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NASA Headquarters
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MEETING REPORT

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SPACE SCIENCE ADVISORY COMMITTEE (SScAC)

NASA Headquarters

July 10-12, 2000

MEETING MINUTES

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Monday, July 10Announcements/Meeting Introduction

Dr. Andrew Christensen, who chaired the first day of the meeting in the absence of Dr. Steven Squyres, called the meeting to order and welcomed members and attendees. He noted that Dr. Squyres was at JPL today attending a crucial review of options for the Mars 2003 mission but would be in Washington tomorrow morning for the remainder of the SScAC meeting. After introductions and logistics announcements, the meeting proceeded with the scheduled presentations.

Mars Program Restructuring

Mr. Scott Hubbard, the recently appointed Mars Program Director at NASA Headquarters, provided a status report on the Mars Exploration program. He noted that the program is now in the middle of the restructuring process, and he would only be able to provide a snapshot of where things were. Few decisions have actually been made to date. In response to the recommendations of the Young Committee, clear lines of authority and responsibility have been established. The Mars Program Director has full budget and program authority for the program from formulation through development and operations. The Mars Program Scientist (Dr. Jim Garvin) leads the development of Mars science requirements for the Program Director. The Mars Program Manager (Dr. Firouz Naderi) at the Lead Center (JPL) has full responsibility for program implementation (subject to Headquarters requirements). Deputy Associate Administrator Earle Huckins has led the program replanning to date for the Office of Space Science (OSS). This responsibility will be transferred to Mr. Hubbard. A Mars Executive Planning Team (which includes representatives from concerned NASA Headquarters offices together with the international partners) has been established to oversee the effort.

Mr. Hubbard continued by reviewing the missions that are in the current planning process. The decision has been made to proceed with the Mars 2001 Orbiter scheduled for launch in April 2001. It is imperative that this mission succeed. Assuring that success is Mr. Hubbard's number one priority. An independent Red Team is reviewing whether all of the findings of the Mars Climate Orbiter (MCO)/Mars Polar Lander (MPL) reviews have been addressed in preparing to implement this mission. NASA has decided not to launch the 2001 Lander, but the existing flight hardware may be used on a future mission. The process to select the 2003 mission is underway. Studies have now focused on two options: (1) a Mars Global Surveyor (MGS)-class orbiter and (2) an Athena-class rover and instruments using a Pathfinder-type landing system. There will be reviews of these options at JPL in July. Time is of the essence in making these decisions because there are only 36 months to launch. The final decision criteria for selection of flight elements and science payload must stress mission success and cost realism. In response to a comment, Mr. Hubbard agreed that there must be much more of an emphasis in the

future on developing the technology to land on the surface safely and operate on the surface routinely. There will also be much more of an emphasis on looking at the program as a whole and examining a wide variety of ideas and concepts as part of the replanning process. The new program must include robust technology and testing efforts. A number of SScAC members noted that the most interesting places are also the most difficult to get to and operate at, and these considerations must be built into the planning and the technology program. Mr. Hubbard responded that all of these issues would be considered in looking at the program for 2005 and beyond.

With respect to the longer-term program, Mr. Hubbard stated that the replanning effort would utilize skills across all of NASA as well as from other agencies and organizations. The focus will be on a consideration of the program as a whole and not on a set of uncoupled missions, artificial and unrealistic constraints will not be imposed, and science will drive the mix of what will be done and when. There will be a major outreach effort to gather concepts and ideas consisting of four parts: industry studies, a workshop to gather new ideas from individual scientists, Center studies, and international discussions. Dr. Papike noted that people had been excluded from participating in the workshop and that such exclusion was likely to send the wrong message to the scientific community. Mr. Hubbard responded that the program had tried to organize a meeting of tractable size and had clearly underestimated the interest in participation. He felt that this workshop was really the start of an ongoing process and that there would be future opportunities for input. Dr. Das stated that the program should develop a set of common services and capabilities for all missions. For example, every mission should not have to reinvent its own communications capabilities. Mr. Hubbard stated that such issues are being considered as part of the replanning process.

With respect to international participation, Mr. Hubbard observed that international collaboration is valuable, but does not come without some overhead. The issue of whether such partners should be on the critical path also requires careful thought. There have been previous successful examples (e.g., Galileo) where international partners have been on the critical path. The right balance point must be found. The International Trade in Arms Regulations (ITAR) are being interpreted with a new vigor, and dealing with these more strictly interpreted requirements has already caused some difficulties for both individual scientists and projects. It appears possible to work within the framework of regulations, but doing so will introduce an additional time factor into the system. Dr. Smith noted that report language contained in the House Appropriations Bill calls for NASA and the Department of State to reexamine the impact of ITAR on NASA's science programs. Dr. Marc Allen noted that there was a meeting at the National Research Council (NRC) on this subject a couple of weeks ago. The NASA Advisory Council (NAC) is also concerned about this issue.

Returning to the subject of replanning, in addition to the efforts described earlier, several synthesis activities have also been initiated. A core group of scientists is structuring a science investigation roadmap, and a NASA team is preparing a technology roadmap. There will be several retreats in August and early September—a large retreat to address the science, technology, and technical aspects, and a second smaller retreat to refine the

plan and address programmatic issues such as cost and implementation approach. NASA will present the plans resulting from all of these activities for review to several groups in October/November—the Mars Program Independent Assessment Team (MPIAT), Solar System Exploration Subcommittee (SSES), SScAC, and the National Academy. The target date for publication of the new program plan is early November. Mr. Hubbard proposed formation of a new Mars Program Task Force reporting to SScAC to take a broad view of the program and help make sure that all of the pieces are coming together in a reasonable way. It would be advisory to the Mars Program Director and emphasize program science and mission integration and technology needs. Mr. Hubbard asked that the SScAC consider this proposal and provide a response. This issue was considered at some length later in the meeting.

Key comments made during the wide-ranging discussion that followed Mr. Hubbard's presentation included the following: In the past, there has been a lack of integration of science and engineering at all levels. This situation must change, and the program needs to work hard to have this dialogue occur at all times. There needs to be a regular forum for exchanging ideas, and the program needs to be flexible enough to respond to changes and new discoveries. Overall, the program is going in the right direction. The Task Force is envisioned, at least in part, to be one way to bring representatives of the different communities together to help achieve the necessary integration. A variety of other mechanisms for achieving this end will be required as well. The Task Force also needs to work on the question of what constitutes a program—what makes sense and what doesn't. It will not replace the significant study capabilities at the Centers and in industry but will provide an extremely important periodic sanity check. There also needs to be a regular way of disseminating information to keep the vision of Mars Exploration before the public eye. A robust test program must be part of future missions. There must be a balance between an overly constrained program and a single large mission every 10 years. There have been successful missions that have shown that the Faster-Better-Cheaper (FBC) approach can be implemented successfully and risk can be managed appropriately and effectively (e.g., MGS and Lunar Prospector). SScAC members expressed their appreciation to Mr. Hubbard and to Dr. Firouz Naderi for all the work that has been done to date. The process so far seems to be heading toward producing a sensible Mars program, and the Committee's comments have been directed toward making sure that the effort continues in that direction. With respect to the proposed Task Force, Dr. Christensen asked that Mr. Hubbard provide the SScAC with a draft Charter for review and discussion as part of the process of formulating a Committee recommendation as to whether such a Task Force should be established.

OSS Strategic Plan

Dr. Marc Allen invited comments on Version 5 of the Strategic Plan, which was distributed to the SScAC before the meeting. He indicated that a preliminary layout of the Plan would be available for review later in the meeting and invited Committee comments on the overall Plan. Dr. Allen noted the major changes made since Version 4 and discussed the comments received from the Space Studies Board (SSB) and how these comments were dealt with in the current version of the Plan.

The SSB felt that the Plan should be expanded to include more explicit attention on how priorities are set, what those priorities are, and program timelines and resource requirements. It recommended that the Plan more thoroughly address the OSS approach to involving institutions outside NASA and how OSS will work to coordinate program planning with non-U.S. agencies. Dr. Allen commented that the next strategic planning cycle should address the issue of international planning and the process for international coordination of programs much more thoroughly than has been done to date. The Board suggested that the Plan have a better description of the Research and Analysis (R&A) and Data Analysis (DA) programs. The SSB recommended the inclusion of additional material on the connection of technology activity to future missions and providing a more concrete set of actions to be taken to realize education and public outreach goals and objectives. It also suggested that the Plan acknowledge the recent mission failures and address how those failures and the resulting assessments affect OSS strategy and program implementation. To the extent possible, all of the SSB suggestions were incorporated into the Plan. A letter to the SSB will be prepared summarizing how the SSB comments were addressed.

Other items still to be incorporated in the final text include: Dr. Hawkins' suggestions on education and public outreach, language on the importance of sounding rockets and balloons in the overall program, and new material for the R&A section. Dr. Smith and others noted that the theme of human exploration is still more apparent in the "Vision of the Future" section at the end of the Plan than they were comfortable with. The last word should really be about science. Dr. Richstone felt that the "Vision of the Future" section is much improved, but there is still a problem with balance—the section provides an unbalanced vision of the long-term future of the Space Science program. Comments were made concerning the need for some material on how this Plan was created—perhaps in an Appendix. Dr. Farmer suggested that the Plan needed a higher level discussion of Astrobiology rather than just a distribution of comments throughout the text. Connections to gravitational and evolutionary biology also should be made. Dr. Allen requested that any other specific comments be provided in writing to him or Dr. Rosendhal. OSS is targeting to have the Plan released in the September time frame.

OSS Program /Budget Status

Dr. George Withbroe provided the OSS overview on behalf of Dr. Weiler. He discussed recent science highlights including Chandra x-ray images of Supernova 1987A and results from the BOOMERANG balloon experiment that will be discussed in more detail later in the meeting. He reported on the successful controlled reentry of the Compton Gamma Ray Observatory (CGRO) on June 4, 2000, and noted that CGRO has been a very successful observatory that operated for more than 4 years past its prime mission. The Near Earth Asteroid Rendezvous (NEAR) is still orbiting Eros and interesting images are being released. Important results continue to be obtained from the Mars Global Surveyor.

Dr. Withbroe then turned to a discussion of the status of missions now in development. A large number of problems of varying degrees of seriousness are becoming evident throughout the program. The Thermosphere-Ionosphere-Mesosphere Energetics and

Dynamics (TIMED) mission is co-manifested with a Code Y payload which is behind schedule. There are cost issues on the Solar Terrestrial Relations Observatory (STEREO) and Solar-B missions. Because of the large degree of international participation in STEREO, the effects of ITAR are also becoming serious. The High Energy Transient Explorer (HETE)-2 mission encountered problems during test, and changes are being made. It will be launched later this year assuming that problems with the Pegasus launch vehicle also can be resolved. The High Energy Solar Spectroscopic Imager (HESSI) spacecraft was extensively damaged during a vibration test. Repairs are now underway aiming towards a launch in 2001. Europa Orbiter and Pluto/Kuiper Express are both in trouble because of cost growth. This will produce delays in the launch schedule. There are also major issues associated with the availability of power sources for these missions. The Next Generation Space Telescope (NGST) is also having budget problems as is ST-3 and the Space Interferometry Mission (SIM). There are also cost concerns on Genesis. The Mars failures have increased the number of reviews required for many missions and these new requirements are impacting costs across the board. The Microwave Anisotropy Probe (MAP) is breaking its cost cap and launch is slipping. Keck is overrunning. If the Hubble Space Telescope (HST) servicing mission slips, there will be additional cost impacts. Accommodating cost growth on Gravity Probe-B (GP-B) continues to be a significant issue. A set of key technical milestones has been established for this mission over the next six months and continued funding depends on meeting those milestones. The SScAC was specifically interested in learning more about the status of this mission from Dr. Weiler later in the meeting.

Most of the new money in the proposed NASA 2001 budget now before Congress is for Space Science—the Living With a Star (LWS) initiative (a major augmentation), additional funding for the Mars program, funds for future mission studies in Solar System Exploration, Discovery micromissions, reinstatement of the New Millennium program (as a competitive, flight validation program), and astrobiology instrument technology. The House Appropriations Subcommittee mark-up (the only congressional action taken to date) eliminated the funding for LWS, but there is a good chance that the Senate will restore this funding. Dr. Withbroe noted that there is language in the House Appropriations Subcommittee Report raising issues about shortfalls in Data Analysis funding. From OSS's perspective, Research and Analysis/Data Analysis funds are projected to have substantial growth over the next several years. The FY 2001 budget now before Congress contains increases in the combined research and data analysis budget of about 8% per year from 2001 to 2005. New initiatives such as LWS also contain substantial research funding. Data Analysis funding is also being built into mission budgets. In the case of Solar System Exploration missions, this approach represents a substantial change from the way missions have been budgeted in the past. Dr. Papike indicated that there is still not enough money going into research in Solar System Exploration and to the analysis of mission data. Other Committee members suggested that, because of its history, this might be a situation that is unique to Solar System Exploration and that steps are being taken to correct the problems. There were also comments that there are some issues which members of the community should not be bringing to Congress. Dr. Rosendhal suggested that this whole subject be a second discussion topic with Dr. Weiler.

With respect to the operation of the OSS organization, the Science Directors now have full and total control of the budgets and programs in their themes. At Headquarters, each mission will be led by a triad of individuals--the Theme Director, a program executive, and a program scientist—who will have full responsibility and accountability for each mission. The Mars program will have its own Director. In order to provide better continuity between the study and development phases of missions, the Advanced Mission and Technology Division has been merged into the Mission and Payload Development Division. The new Division, led by Dr. Ken Ledbetter, will manage all advanced technology and flight program development efforts. Dr. Guenter Riegler will continue to manage the Research Division. Dr. Ulrich has been assigned to the new position of Technology Director for OSS. Dr. Rosendhal noted that Dr. Ulrich would be updating the SScAC on all of the changes in the technology area later in the meeting.

Science Talk

Dr. John Ruhl from the University of California, Santa Barbara, gave a lunch-time science talk on BOOMERANG, a balloon mission supported by the R&A program that was launched on December 29, 1998. The mission of BOOMERANG was to map the Cosmic Microwave Background (CMB) radiation at much higher spatial resolution than was done by COBE. BOOMERANG, an international collaboration, was the first cosmic background instrument to fly around Antarctica. About 190 hours were spent observing the CMB. Various galactic sources were also observed. The analysis of the data has been a complex and laborious task. Results of the analysis done to date (only a small portion of the data) provide tight constraints on the geometry of the universe and suggest that the universe is flat. Further analysis is underway, and the results—which only cover a small portion of the sky—will set the stage for the more definitive measurements to be made by the MAP and PLANCK missions. The balloon payload is now being refitted for a flight next year to search for evidence for polarization of the Cosmic Microwave Background radiation.

Ethics Briefing

Mr. Andrew Falcon gave the Subcommittee its annual ethics briefing, as required by the Federal Advisory Committee Act (FACA). Mr. Falcon noted that the activity of the committee have to be managed to ensure that it stays within the bounds of FACA, and the committee members have to be aware of potential conflict of interest situations, in particular with respect to their employer. The Executive Secretary is the first line of defense for the members. One important role of the Executive Secretary is to keep an eye on conflicts of interest. There has been a fair amount of concern in the ethics area over the past several years. Mr. Falcon invited members to contact the ethics officials for any questions regarding ethics rules or a particular situation. He emphasized that there are a lot of resources in the Agency to help members resolve ethics issues, and they should be used in advance of a potential problem.

Subcommittee Reports

Dr. Bruce Margon reported on the Structure and Evolution of the Universe Subcommittee (SEUS) activities over the past few meetings and on recent accomplishments in the field.

He began by noting that the Astronomy and Astrophysics Survey Committee (AASC) reported its results in May and that all three of the major SEU Roadmap missions were very strongly endorsed—Constellation-X, the Laser Interferometer Space Antenna (LISA), and the Advanced Cosmic-ray Composition Experiment on the Space Station (ACCESS). Dr. Margon noted some of the SEU accomplishments over the past year. Both Chandra and the ESA X-ray Multiple Mirror (XMM) were launched successfully and are producing a wide variety of important scientific results. Instruments and investigations for the Gamma ray Large Area Space Telescope (GLAST) have been selected. The proposed Cosmic Journeys Initiative seems to have succeeded in providing the broad, coherent intellectual framework for the SEU missions that has been lacking up to the present time. Presentations on this Initiative to the Administrator and to a number of key groups have been well received. Recent issues addressed by SEUS include the Supporting Research and Technology (SR&T) program restructuring; the International Space Station (ISS) attach points; FY 01 and 02 budget pressures on Constellation-X, LISA, and ACCESS; the need for a flight technology demonstration for LISA; and reorganization of the cross cutting technology programs. With respect to the ISS attach points, the issue is two large passive payloads that are well suited for use on the ISS. Space is already committed for 3 years to the Advanced Magnetic Spectrometer, and it is not clear when the single attach point will be available for use by ACCESS. The fact that there is only one attach point is now choking things. Why is there only one attach point? Dr. Gehrz suggested that SScAC receive a briefing on ISS attach points at the next meeting. The Committee needs to hear more about this topic. With respect to other critical issues, Dr. Margon noted that the need for a LISA technology demonstration is becoming very pressing. Such a demonstration is now in the critical path. He also commented that the reorganization of the technology programs introduces another layer of people into the decision-making process as to what technologies should be supported. Dr. Margon concluded by highlighting some recent science results that clearly demonstrated the power of being able to do high-resolution x-ray spectroscopy as a major future direction for the field.

Dr. Alan Dressler reported on the Astronomical Search for Origins and Planetary Subcommittee (OS) meeting in June. He noted that several of the major upcoming Origins missions—the Space Infrared Telescope Facility (SIRTF), the Stratospheric Observatory for Infrared Astronomy (SOFIA), and SIM--were not on the AASC list because they were considered in previous surveys. All were reendorsed by the AASC. As far as new missions are concerned, NGST received the highest endorsement from the AASC clearly justifying the role it plays in the new OSS Strategic Plan. The Terrestrial Planet Finder (TPF) was embraced enthusiastically, although there were concerns over whether it really belonged in the decade covered by this Report. At the June meeting, the OS focused on issues associated with four missions: SIM, SOFIA, NGST/Nexus, and the HST/Wide Field Camera (WFC)-3. Dr. Dressler commented that there is now growing pressure on the Origins budget from a variety of sources, and there are significant issues associated with nearly all Origins missions. Issues considered by the OS seemed to be the most pressing in the near-term. The OS reiterated the importance of keeping the HST healthy through the next decade, recognizing that reduced operations costs will be reduced in order to proceed with the timely development of NGST. The planned

complement of HST instruments will allow a vigorous program of science to be conducted throughout the remainder of its lifetime. The Subcommittee felt that the WFC-3 is a very desirable instrument because it will provide a unique capability to do wide-field UV imaging. However, the OS was also concerned that, unless costs are carefully controlled, WFC-3 could delay the development of NGST. If cost containment actions become necessary, retaining the IR channel is not as important as having the UV imaging because NGST will eventually provide a far superior IR imaging capability. Depending on how development work on NGST is actually proceeding, at some point the desirability of carrying out an additional HST servicing mission may also have to be considered. The OS was concerned whether the budget for SIM would be sufficient to meet the planned scientific and technical goals. The next year will be critical. Every effort must be made to keep this mission within reasonable cost and to define realistic science requirements. The Subcommittee recognized that significant budget issues were emerging in the SOFIA program and favored using the early operating funds as the first resource for solving capital cost issues. In particular, the science data system must be funded (it is crucial for meeting the needs of Guest Observers) even if funding for one or two of the facility instruments has to be deferred in the near term. With respect to NGST, the Subcommittee was impressed with progress to date but, there are serious concerns about cost growth. An independent cost assessment is strongly recommended. Regarding the proposed NGST precursor, Nexus, the OS agreed with Mr. Goldin that only those technologies that really need to be tested in space should be tested in space. The Nexus cost and schedule also need to be assessed very carefully so that the precursor mission does not consume a large fraction of the budget and become a threat to the development of NGST itself. The OS feels that it is extremely important that NGST fly within the next decade. Any demonstration mission should be carefully scoped to minimize impacts on NGST's budget and schedule. There were also concerns that there would not be enough time to incorporate Nexus results into the NGST program, raising serious issues about either the role of the precursor mission in the overall program or whether there would be important unaddressed technical issues when NGST itself went into development. In response to a question regarding the status of Nexus, Dr. Kinney indicated that she felt there is a real requirement to test key technologies in order to be able to proceed with NGST. The question is how much can be done on the ground and what needs to be tested in space. An independent review is needed to assess the risks associated with various technologies and decide which technologies must actually be tested in space.

Dr. Michael Drake reported on the Solar System Exploration Subcommittee (SSES), which also met in June. He noted that current Solar System Exploration missions (NEAR, Cassini, Galileo, Mars Surveyor, and Stardust) are going well. He also commented that the discovery of water close to the surface of Mars could change the whole strategy for the exploration of the planet. The SSES has a high degree of confidence in the current leadership on the Mars program and looks forward to the definition of a prudent and sensible long-term program of Mars exploration. On the negative side, some major concerns are emerging. The Outer Planets program is underfunded and at risk. The sequence of missions has been changed (Pluto/Kuiper Express in 2004, Europa Orbiter in 2006, and Solar Probe in 2007), primarily due to

technical problems associated with the availability of power supplies for Europa Orbiter. These changes should have little impact on the science. However, the new funding profiles show significant cost growth and contain large increases in individual years. In the view of the SSES, most problems could be solved if the entire program is slipped by 1 year, but other scenarios (such as canceling Pluto/Kuiper Express) are also being discussed. At least all the real problems are now out on the table, so there is a basis for understanding what the realistic options might be. Within the Solar System Exploration program, there are also critical issues associated with the funding of extended missions. To date, the approach has been to budget for minimal missions and then hope that additional support for continued operations and data analysis can be found later. A more realistic approach must be taken in the future. Funds for extended missions must be included in the budget. Adequacy of basic research funding in this theme also remains an issue. There is inadequate funding to extract the full scientific return from planetary missions. At the very least, inflationary increases should be provided in the core discipline programs, and long-term data analysis lines should be added to all missions. The theme needs to consider the real requirements for realizing the scientific benefits from missions and not just focus on getting missions off of the ground.

Dr. Andrew Christensen reported on the Sun-Earth Connection Advisory Subcommittee (SECAS) meeting in June. The SECAS was generally pleased with the progress that has been made on the Living With a Star initiative. The Subcommittee strongly supports creating a Science Architecture Definition Team to assure that a broad perspective is brought to the planning of the Initiative. Strengthening education at all levels should be an important element of the science architecture. Dr. Christensen indicated that ITAR problems have had a significant impact on the Solar Terrestrial Relations Observatory (STEREO) project and strongly supported efforts to mitigate the impact of ITAR on NASA science programs. In general, SECAS has been pleased with progress made on technology development for the Solar Probe and reaffirmed the importance of maintaining the planned Solar Probe launch in 2007. The SECAS is concerned that budget problems on other missions in the Outer Planets line might impact the launch schedule for Solar Probe and is anxious that this not happen. The Subcommittee is extremely concerned that a critical funding situation has developed as a consequence of the privatization of the Sounding Rocket program. Costs have increased to the point where a viable launch schedule cannot be supported with the existing funding profile. There is a \$10M/year shortfall. The SECAS strongly recommended that funding be identified to sustain a reasonable launch rate for this program. The rocket program provides low-cost, frequent access to space for science investigators. In addition, a large part of the training of both engineers and scientists has come through the rocket and other sub-orbital programs. Neither the scientific community nor the Agency can afford to lose the benefits of the rocket program, and a way must be found to address this issue. SECAS is also concerned with the potential for erosion of science content in the Explorer line. New requirements for system redundancy are appearing, additional reviews are being put in place, and additional reliability studies are now being imposed--all of which are putting additional strains and financial stresses on the Explorer program. SECAS believes that a careful evaluation must be made of the costs of placing additional risk reduction requirements on Explorers against the value added to the program of meeting

such requirements. New requirements should be placed on missions only when they can be shown to genuinely add value and reduce risk and not just imposed for their own sake.

During general discussion, the SScAC identified several potential items to discuss with Dr. Weiler on Wednesday. These included GP-B, SR&T, and the Mars Program Task Force. In general, the SScAC felt that the Strategic Plan was in good shape and reiterated that it is important that it be released on schedule. A number of people noted that the Plan does not take a consistent approach as to what is and isn't mentioned in the Plan as derived from the Roadmaps and that a careful look at this issue should be taken in preparing the final version. Dr. Christensen observed that the overall Plan document successfully conveys the program that has been endorsed by the SScAC. The SScAC also affirmed the importance of the proposed Mars Program Task Force and encouraged that it be put in place as soon as possible.

Tuesday, July 11

Dr. Christensen continued to Chair the meeting for the first two agenda items. Dr. Squyres assumed the Chair following his arrival from California at 10:00 a.m.

Explorer Program Status

Mr. Marcus Watkins began his overview of the Explorer program by reviewing some key events of the past year. He noted that the TERRIERS mission launched in May 1999 was lost when, due to a software error, the spacecraft was pointed in the wrong direction causing the batteries to become depleted. The Far Ultraviolet Spectroscopic Explorer (FUSE) was successfully launched in June 1999 and is now starting to produce a wealth of scientific results. The Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) spacecraft was also successfully launched in March 2000 and is starting its science mission. Many of the missions now in development are encountering either cost or technical problems. The HESSI spacecraft was severely damaged during a vibration test. A recovery plan is now being developed. MAP is in integration and test, but there are cost problems developing. The Galaxy Evolution Explorer (GALEX) is in integration but is being affected by problems with gyros first identified in tests of similar gyros during development of the FUSE mission. In addition to technical problems, the HETE-2 launch schedule has been affected by problems with the Pegasus launch vehicle. All Pegasus launch vehicles are now in a standdown pending resolution of problems identified during a recent launch failure. The Cosmic Hot Interstellar Plasma Spectrometer (CHIPS) mission is just completing its Phase B study. The Inner Magnetospheric Explorer (IMEX) is continuing its Phase A study. However, it is not clear whether there will be an affordable launch vehicle for this mission. With regard to the recently selected Medium-class Explorers (MIDEX) missions, SWIFT is in Phase B, and the Full-sky Astrometric Mapping Explorer (FAME) is just starting its Phase B studies. Implementation of FAME has been delayed by 1 year in order to deal with other budget problems in the Explorer line. The Cooperative Astrophysics and Technology Satellite (CATSAT) is scheduled to begin environmental testing at GSFC this month.

In response to a question, Mr. Watkins reminded the Committee that there are three classes of Explorers—University Explorers (UNEX), Small Explorers (SMEX), and Medium-class Explorers (MIDEX), with the three classes intended to provide a set of continuing, relatively frequent flight opportunities of different scales. The mission classes and cost caps for each of those classes were established several years ago. Missions of Opportunity funded out of the Explorer program are also solicited in conjunction with each Explorer Announcement of Opportunity. Dr. Rosendhal noted that there was a major change in the Explorer program in 1988. At that time, Dr. Fisk rescoped the Explorer program, eliminated the Delta-class Explorers, put firm cost caps in place, and introduced the SMEX concept. The current mix is the result of evolution of the program over the past twelve years. Mr. Watkins also indicated that, based on experience to date, the viability of the UNEX concept is now being reexamined and a decision as to whether to continue this line will be made in the near future.

Mr. Watkins indicated that the Explorer program is being affected by new requirements for reviews and testing in the aftermath of the Mars program failures. Meeting such new requirements (which have been imposed late in the development phase for some missions) costs money, and dealing with the extra costs is starting to create schedule delays. The underlying issue for the Explorer program is how much risk is appropriate/acceptable? The program is dealing with a major change in risk philosophy and how the issue will sort itself out is still uncertain. Different levels of risk may be acceptable for different classes of mission, but no firm policy has been set as to how to define such levels of risk. However, it is clear that the Agency does want a more formal approach to risk analysis and risk management and a clearer definition of the risks associated with each mission. Dr. Christensen noted that the science community should be part of the “buy in” to the decision as to how much risk is acceptable. There is fear in that community that imposing additional reviews and requiring a redundant system will increase costs and reduce science content because there will be fewer Explorer missions. A number of Committee members commented that simply adding reviews does not necessarily add value to programs. However, modest investments in additional testing can be very valuable. Mr. Watkins noted that a NASA Integrated Assessment Team (NIAT) is going through the various failure reports and is identifying ways to reduce the overall risk level while keeping a robust program in place. Dr. Zuber added that what the Young Committee and other reviews found was that there is not a consistent view in the Agency as to what constitutes “acceptable risk.” There is also no common philosophy regarding requirements for testing. Missions have been “buying in” and program budgets have not had adequate margins. She also commented that it might be acceptable to fail if you are really doing something brand new. It is definitely not acceptable to fail if you are careless about doing something routine. Dr. Gehrz pointed out that Mr. Goldin has been consistent about saying that there would be failures. These statements attracted little attention until there actually were failures.

Mr. Watkins continued his presentation by showing the impact of the new NASA Launch services (NLS) Contract Prices on MIDEX missions. The problems discussed so far are not the only ones affecting the Explorer program. The most recent competition for launch vehicle services has led to considerably higher launch prices than anticipated, and

the only way to deal with the resulting budget impacts is to delay future Announcement of Opportunities (AO's) and stretch out programs. Mr. Watkins commented that the launch cost situation is generating all sorts of ripple effects superimposed on the myriad other problems that have just been discussed. As a consequence, the schedule for the release of future AO's is now being reexamined.

Structure and Evolution of the Universe (SEU) Theme Report

Dr. Alan Bunner provided an update on the SEU theme. He noted that there have been a number of press releases on SEU missions and investigations as well as a series of space science updates on the results from SEU programs. The theme is clearly receiving a lot more public attention. Dr. Bunner discussed the proposed Cosmic Journeys Initiative. He pointed out that the content of this Initiative is now part of the OSS 2000 Strategic Plan, and the Administrator has been very supportive of the approach that has been taken. Cosmic Journeys missions are now high priority in the Academy's Astronomy and Astrophysics Survey Report. The National Academy has also started a new survey—"Physics of the Universe: From Quarks to the Cosmos"-- to examine the important science to be done in the area where space science and fundamental physics overlap. Michael Turner is chairing this study, and a report from this group is expected by January 2001. DoE and NSF have both exhibited a lot of interest in this area of study. Fundamental Physics is clearly becoming an important element of the SEU theme. The proposed Cosmic Journeys Initiative contains a new Fundamental Physics element in the R&A program, and one of the new positions being established in the Research Program Management Division is a Discipline Scientist for Fundamental Physics. Many of the missions in the SEU theme have strong requirements for the development of new technology. A technology program is also a part of the Cosmic Journeys Initiative. The primary issues facing the SEU theme are: getting the Cosmic Journeys line into the federal budget (in Dr. Bunner's view the future of the theme is dependent on this new Initiative); reaching closure on the best option for proceeding with a near-term space technology demonstration for LISA (the ST-3 mission may be able to accommodate a LISA test package as a piggyback experiment); and identifying near-term funding in FY 2001 (\$7.5 million) to get started on critical LISA technology work. There are also issues concerning whether important SEU-related technology work now contained in the cross-cutting technology program will continue to be supported now that this program has been moved from Code S to Code R. GP-B is also a major budget problem for OSS. Solving the GP-B budget problem will have an impact on other parts of the OSS program. For example, one of the scenarios now being discussed to accommodate GP-B is for NASA to reduce its planned participation in the ESA Far Infrared Submillimeter Space Telescope (FIRST) mission. There are likely to be impacts on European Space Agency's (ESA) willingness to collaborate on other NASA programs if such a decision is made.

NASA-University Study

General Spence (Sam) Armstrong, Senior Advisor to the Administrator, discussed the ongoing NASA study on the Agency's relationship with universities. He noted that the study began in February and that he has already visited a number of campuses and attended several university association meetings. It is already clear that there are areas

where NASA needs to do some work to be more “customer-friendly”—ITAR and the way that NASA handles grants. General Armstrong feels that it is his role to become an ombudsman for universities at NASA. With respect to ITAR, he noted that the regulations are confusing. Language in the House Appropriations Bill specifically directs OSTP to work with NASA and the Department of State on the ITAR issue, and a number of meetings have been held to date on this subject. The regulations specifically exclude basic research from the export control laws; and when the Commerce Department was in charge of overseeing the application of the regulations, a very liberal interpretation was taken. Because of recent congressional concerns on technology transfer, responsibility for overseeing the regulations was transferred to the State Department which has interpreted the regulations far more strictly. General Armstrong noted that a survey was now underway trying to assess the impact of ITAR on university research. A number of SScAC members commented that it is important that this activity is underway. In their view, the ITAR interpretation being taken by the State Department is adversely affecting science programs, and it is critical that the exemption from the regulations for fundamental research be reestablished. Right now people are being very conservative about interpreting the regulations because they don’t really understand what is required. General Armstrong stated that NASA is looking at actions that it can take with respect to future programs. The State Department states that fundamental research is exempted, as long as it is not proprietary, is unclassified, and is publishable. However, Category 15 of ITAR includes space systems and associated equipment under export controls designating them as “specialized military equipment.” Technical data related to the manufacture of all spacecraft is also covered. Such a broad interpretation is affecting virtually everything that NASA does. NASA will continue to work on this critical issue. General Armstrong stated that, in his view, it is clear that the State department and the Congress don’t understand the impact of ITAR on research and on the universities.

With respect to grants administration, General Armstrong noted that NASA is more of a contracts culture than a grants culture and therefore may impose many accounting requirements on grants that don’t necessarily make sense. Many of the problems can be solved by actions that NASA itself can take. General Armstrong is working with the financial and procurement people on this issue. Universities will also be surveyed regarding problems introduced by the grants process. Dr. Richstone commented that NASA ought to be talking to the principal investigators (PI’s) as well as Sponsored Research Offices and university administrators. Problems may be seen very differently at different levels in the university system.

Astrobiology Task Force Report: The Astrobiology Laboratory

Dr. Squyres introduced the Astrobiology Task Force/Astrobiology Laboratory discussion by noting that the Ames Research Center (ARC) has proposed building a brick and mortar facility for Astrobiology. This has been a contentious topic for some time. Based upon both reports from the Astronomical Search for Origins Subcommittee (OS) and discussions at a number of SScAC meetings, the SScAC has had very strong reservations about the establishment of such a Laboratory. At the last meeting, the SScAC made two recommendations about the proposed NASA Astrobiology Research Laboratory (NARL): (1) That the new Astrobiology Task Force look carefully at the need for and scientific

importance of the NARL; and (2) if a decision is made to go forward with an NARL, the establishment and operation of such a facility should be openly competed. SScAC asked the Task Force to do the legwork on the Laboratory issue; and one question that must be addressed at this meeting is whether the Task Force has had an adequate opportunity to do its job. SScAC should not make a recommendation unless it is satisfied that the issue has been carefully considered. There must be no doubts about the credibility of whatever position SScAC takes on this subject.

Dr. Chas Beichman, Chair of the Astrobiology Task Force, briefly described the Task Force Charter and its composition and then discussed its review of the NARL concept. He noted that this review was based on the results contained in the Interim report produced by the Science Definition Team (SDT). A telecon was held to discuss that report on June 6, 2000, and a Letter Report describing the Task Force findings was submitted to NASA Headquarters on June 12, 2000.

The main Task Force findings contained in that Letter report were:

- The SDT did an excellent job of canvassing the Astrobiology community and considering a wide range of possible activities for a National Laboratory.
- The Task Force agreed with the SDT finding that no funds should be taken from the NASA Astrobiology Institute (NAI) or existing Astro-, Exo-, or Evolutionary Biology grants programs to equip or maintain such a Laboratory. Such an action would gut existing programs (which are already underfunded in the view of the Task Force) and would create a long-term lien on the Astrobiology budget for instruments, laboratory operations, and providing research support for NARL staff.
- None of the three research areas identified in the SDT report were compelling enough to warrant the establishment of a major new dedicated research facility. Relevant experiments can be carried out by individual investigators located at laboratories around the country using their own facilities. Biology is not like physics or astronomy where major pieces of research equipment at central locations are required for use by a broad community of scientists.
- The SDT identified legitimate scientific uses of a NARL on the presumption that it already exists but did not identify any activity that was sufficiently compelling that it alone, or in combination with others, would justify the creation of the NARL. Interesting areas of laboratory work identified by the SDT do not warrant the establishment of a new national facility.

In response to a question, Dr. Beichman acknowledged that the Task Force did not hear directly from the advocates of the NARL. They worked primarily with Professor Don Lowe—the Chair of the SDT—and used him as a conduit for information about the Laboratory. Dr. Beichman also stated that the Task Force did not feel entirely comfortable with the time pressure for its deliberations. Perhaps two things could have been done in a more deliberate way. The group might have considered the final SDT

Report (due in the fall) and had direct discussions with the ARC advocates of the Astrobiology Laboratory. However, it is not clear that the Task Force conclusions would have changed with more time for discussion. The Task Force findings were unanimous, and the group felt that it had adequate information to consider the issue.

Discussion

Dr. Bruce Jakosky and Dr. Ken Nealson, members of the SDT, participated in the SScAC discussion via telecon. Dr. Jakosky indicated that he felt that the review and assessment was a fair one. Both commented that the SDT felt that progress in the field did require investments in major facilities that could not be acquired through a modest augmentation in the research program. Whether these facilities need to be colocated in an 80,000 square foot building is another story. Dr. Nealson noted that there was a very diverse set of people (having a wide range of opinions) on the committee, and he felt that the SDT report was a very fair representation of a middle ground. With regard to computational Astrobiology, the issue isn't one of access to computing power but rather of being able to assemble a critical mass of people. In response to a question, Dr. Beichman indicated that the SDT was told that the yearly cost for operations of the NARL would be about \$15 million. Dr. David Morrison noted that the building would not be built with NASA funds—NASA funds would only be needed for outfitting and operations (beginning in the FY 02 budget). Dr. Drake reiterated the observation that the key issue for NASA is not the capital cost of the building. It is the funds required to equip and operate the laboratory. These funds are a significant fraction of the current Astrobiology program. Many people feel that augmenting the current research base and providing more adequate funding to the current members of the Astrobiology Institute would be a better use of the money. Concerns were expressed by a number of SScAC members as to whether the Task Force really had adequate time and information to do its job. Dr. Das commented that, perhaps, ARC should be commended for thinking differently. Such innovation is rare in the Government, and there may be an opportunity here that should be taken advantage of. Dr. Farmer said that he was bothered by the fact that the planning seems to be driven by the need to find a use for a building. Many questions need to be answered, and the situation seems to be developing too rapidly to allow a rational assessment. He also noted that building a large facility seems to be inconsistent with the spirit of the NAI. It would be a mistake to destabilize the NAI to build a building. Dr. Gehrz commented that the Task Force did a good job given the time. The Report presents a very negative picture of the proposed Laboratory but does not really address the question of the value of having a closely-knit group of experts working together on common, large-scale problems. Dr. Christensen observed that the need for this type of facility was not identified in the Astrobiology roadmap. Dr. Nealson stated that, at the second Institute PI meeting, a plan for the new building was presented. However, the presentation seemed to be decoupled from any of the known science goals of the NAI. Dr. Jakosky commented that it was presented as an opportunity to get a building. The question then became what could be done with such a building for Astrobiology. Dr. Papike added that clusters of experts are already starting to coalesce through the NAI, and that a focus on building the NARL could actually set the NAI back.

Dr. Squyres summarized the discussion by stating that there were clear concerns about the rushed nature of the review process. There were also concerns that the Task Force did not hear from advocates of the Laboratory and from ARC management. In general, the SScAC agreed with the view of the Task Force that a compelling case for establishment of the NARL had not yet been made. While there are areas of astrobiology research that are exciting and compelling and that could benefit from an augmentation, the same statement could be made for many areas of the research program. To ensure fairness to everyone concerned, the subject of the Laboratory needs to be reviewed in more depth and with less haste. Dr. Beichman noted that the next meeting of the Task Force will take place at ARC in October when the final report of the SDT will be available for review and discussion, and there will be an opportunity to discuss the Laboratory in depth with its advocates. The SScAC will discuss this subject again at its November meeting when a more thorough report from the Task Force will be presented.

Planetary Protection Advisory Committee (PPAC)

Dr. Squyres recalled that there was strong agreement at the last SScAC meeting concerning the need for a PPAC. However, there was not agreement regarding the level at which it should report—as a standing subcommittee of the SScAC (a strongly held minority opinion) or as a Standing Committee of the NAC itself. The two views were presented to the NAC at its meeting in June. The NAC unanimously voted to establish a PPAC reporting to the NAC as a separate Standing Committee. Dr. Squyres stated that there were still open issues regarding the Charter requiring resolution. In particular, the Charter needed to be carefully worded so that the PPAC would not address issues that were purely scientific in nature.

Dr. John Rummel presented the proposed Charter for the new Committee and invited SScAC comment. He noted that the language in the charter must make the NAC's intention clear—the PPAC should not address science issues. The words in the draft “the scope of the Committee's responsibilities will not include issues pertaining solely and exclusively to the quality and interpretation of scientific experiments and data” are intended to capture this thought. Dr. Squyres requested that Committee members send comments on the proposed Charter to him and Dr. Rummel. He reminded the Committee that SScAC has been given the opportunity to provide its input concerning the Charter, and he will present these comments to the NAC. However, preparation of the final PPAC Charter would be done by the NAC itself.

Astronomical Search for Origins Theme Report

Dr. Anne Kinney started her review by presenting some recent science results that imply that life on the land is much older than previously thought and that the Earth's atmosphere contained significant quantities of methane at that time. She noted that the Terrestrial Planet Finder (TPF) would be able to detect such quantities of methane. She also discussed recent studies of black hole demographics that show how 10 years of results can be brought together into a coherent picture. With regard to Origins missions, she observed that most missions are either “yellow” or “red” and that significant financial and/or technical problems have now emerged in most areas of the program. The “Program/Budget Status” and “OS” discussions that took place earlier in the meeting

contain details concerning all of these problems and possible approaches their solution. Dr. Kinney concluded her presentation by discussing a new Origins initiative—the Large Space Telescope System Technology Initiative (LTSI). This initiative will provide the technology needed for developing future telescopes in space with very large (20m-40m) apertures.

Solar System Exploration Theme Report

Dr. Carl Pilcher began his presentation by distributing one of the recent Eros images taken by NEAR. He noted that the linear features prominent in the image were probably due to fractures running through the body of the asteroid. He continued by discussing the recently announced evidence (featured on the cover of Science Magazine) for the presence of recent water seepage on Mars. The key features suggesting such seepage have now been seen at 120 locations. Dr. Pilcher stated that his most serious programmatic concerns all centered on the Outer Planets program. He noted that both launchers and power systems had been seriously underbudgeted and that the Department of Energy has abandoned its efforts to develop an advanced nuclear power source. The availability of plutonium for civil applications is also an issue. Total projected costs for the 3 Outer Planets missions are now up to about \$ 1.5B, and schedules are slipping substantially. Mission costs are getting to the point where the line may become a target. He pointed out that interest in the Europa Orbiter was one of the prime drivers in establishing the Outer Planets line in the first place. If that mission starts to slip badly, the rest of the program becomes much less attractive. Options for proceeding with the Outer Planets missions are being developed and a lot more information on what reasonable options might be will be available by the end of the year. However, there is no doubt that some very difficult programmatic decisions will have to be faced. It is far from obvious that it will be possible to proceed with all 3 of the current missions. Dr. Squyres noted that the problems facing the Outer Planets/Solar Probe line are serious ones having major programmatic and scientific implications that cross themes. SScAC should address these problems. Dr. Squyres encouraged the SSES and the SECAS to find a way to have a joint meeting before the next SScAC meeting to consider the issues. SScAC will revisit the status of the Outer Planets program at the next meeting.

Sun Earth Connections Theme Report

Dr. Withbroe began his presentation by stating that he agreed with the comment that interest in the Europa Orbiter is what made the Outer Planets line possible. Dr. Withbroe then showed recent images and results from the Transition Region and Coronal Explorer (TRACE) and the Solar and Heliospheric Observatory (SOHO) missions. He noted that IMAGE was launched successfully in March 2000 and is starting to produce exciting images of the geospace environment. He continued by discussing recent progress in defining the Living With a Star Initiative. The first new mission in the Initiative will be the Solar Dynamics Observatory (SDO) which will do a much more thorough job of studying the internal dynamics/seismology of the Sun than has been done to date. The goal is to launch SDO by the end of 2006. He noted that the Initiative contains substantial new funds for basic research.

Research Program Report

Dr. Guenter Riegler briefly addressed three areas: OSS's progress on/plans for responding to the Space Studies Board (SSB) Report on the R&A program, material on funding going to the research community developed for the Armstrong study, and the next steps to be taken in organizing the Senior Review Process that will be used to evaluate the overall content of the research program.

Dr. Riegler began by noting that the SSB report addressed space science, Earth science, and life and microgravity sciences; and it was not always clear to whom recommendations were being addressed. One key recommendation was to link the research and data analysis programs much more closely to the goals in the OSS Strategic Plan. In the ROSS 2001 NASA Research Announcement (NRA), relevance to the Strategic Plan will be one of the explicit evaluation criteria. A number of SScAC members observed that the ROSS NRA has gotten very complex and needs to be made more "user-friendly." Following a short discussion of the other SSB recommendations, Dr. Riegler indicated that the SSB has been asked to provide an interim assessment on how OSS is doing in meeting the recommendations. He noted that many of the issues raised by the SSB may, in fact, be more directed towards Codes E/R/U than towards Code S. This subject will be considered further at the SSB Executive Committee meeting this summer.

Dr. Riegler next discussed the data developed by the Research Program Management Division to support the NASA-University Study. He noted that there are three basic avenues for university researchers to participate on OSS programs: hardware development programs for flight missions (oversubscription as high as 20-25:1); data analysis programs for flight missions (the best opportunity for "new" entrants; oversubscription ranges from 1.5:1 to 6:1); and SR&T programs (oversubscription ranges from 3:1 to 5:1). He commented that in 1999 about 11% of the flight development funds went to universities; about 58% of the Data Analysis (DA) funds went to universities; and about 51% of the SR&T funds went to universities. He then presented the charts (shown earlier by Withbroe) on projected growth (about 8% per year) in the support going in to the research community. Committee comments generated by this portion of the presentation included the need for longer-term awards and the need to take a broader view as to what constitutes appropriate activities to be undertaken within the Data Analysis program (e.g., theory and not just number crunching). Dr. Squyres commented that it is clear that NASA's support for the research community is deep and growing but perceived differences between the DA and SR&T programs (and how these programs are used to support the community—a situation that currently varies dramatically from theme to theme) seem to be the source for many of the comments about inadequate support coming from researchers, many of whom are not aware of all the sources of support actually going in to the community.

Dr. Riegler concluded his presentation by discussing plans for the comparative review of the R&A program that will be held next year. At the review, written reports on each research cluster—constituting a "proposal" for that cluster-- will be presented that describe the content of the cluster, its relevance to the goals in the OSS Strategic Plan,

highlights of recent significant accomplishments, and previews of work to be undertaken within the cluster. Since active researchers in those fields can make the best case for a research area, representatives from the research community will prepare the research reports for each cluster. Six of the nine clusters already have teams in place preparing to write the science cluster reports for the Senior Review. Those reports will be the basis for the review by the Senior Review Panel. This panel will consist of active members of the research community with recent research efforts in two or more of the science clusters and selected for their breadth and impartiality. How the review panel gets selected is currently under discussion. The success of the effort will clearly depend on the quality of the review panels. Draft instructions for "proposal" preparation for the Senior Review process will be issued in November. Writing teams should have their first drafts by early January 2001 to be circulated for comment to relevant science working groups and committees. Finalized instructions for "proposal" preparation will be issued in late January after review by the Chair of the Review Panel (who will be appointed in early January). Final "proposals" will be due in March 2001 and the review will be held in May. The target for announcing the results is July in order to be able to make decisions concerning budget allocations across Clusters for FY 2002 and beyond. Dr. Riegler invited the Committee to recommend panel members. Dr. Squyres stated that he thought that this was a well-conceived plan but that it was going to be a significant challenge to carry the activity all the way through to a conclusion. The SScAC will continue to watch the process with great interest and is prepared to offer help if needed.

NASA/OSS Technology Program Reorganization

Discussion of the technology program began with the SScAC accepting the Final Report of the Technology Readiness Task Force (TRTF). Dr. Squyres expressed appreciation for the efforts of the Task force, noted that many of its findings were already helping to reshape the technology program, and stated that the Task Force Report would be transmitted to Dr. Weiler as part of the letter summarizing the recommendations emerging from this meeting.

Dr. Peter Ulrich then discussed recent events affecting the OSS technology program: the appointment of the NASA Chief Technologist as the Associate Administrator for the Office of Aero-Space Technology (OAT); the transfer of the Cross Enterprise Technology Development Program (CETDP) from OSS to OAT; the merger of the Advanced Technology and Mission Studies Division with the Mission and Payload Development Division; the creation of a new position of Technology Director in OSS; and the strong recommendations to strengthen Agency technology development programs contained in various reviews and reports recently submitted to the Agency. Dr. Ulrich described the principal functions of the Technology Director in OSS as being: evaluation of the OSS technology development program to determine its adequacy to support the Strategic Plan; identification of deficiencies within the OSS technology program; maintenance of a proper balance between near-term and far-term investments; and assuring that OAT adequately supports future OSS needs for advanced spacecraft technology. The Technology Director will also be the principal advocate for the technology budget within OSS. In response to the findings of the Technology Readiness Task Force, a Technology Steering Group (TSG) has been created help assure cross-

theme integration of technology requirements and development plans and coordination of technology work being done within OSS with other technology work being carried elsewhere in NASA. The TSG reports to the OSS Technology Director and is composed of representatives (technologists) from each of the themes, the Astrobiology program, the New Millennium program, and the CETDP. A technology representative from the Mars program will also be added to the group. The TSG is in the process of organizing a comprehensive database containing the entire set of technology requirements identified across OSS and all current technology development plans and programs. The database will be used as the principal tool for evaluating the adequacy of the OSS technology program; assuring that an integrated and optimized technology program is being defined and carried out; and monitoring progress on technology programs. Dr. Ulrich felt that the TSG has accomplished a very large amount of work since getting underway in January. He commented that almost all of the Task Force recommendations can be carried out through the TSG and that it will provide a far more integrated view of Code S technology needs than has been possible to date. The TSG plans to complete its analyses with the new tools in time to impact the next budget cycle in the spring of 2001. In response to a question, Dr. Ulrich commented that, with the transfer of responsibility for the CETDP to Code R, OSS has clearly lost a considerable amount of control of the content of that program. As a consequence, it will be much harder to ensure that the CETDP adequately addresses Code S requirements. He also believed that there would be a significant restructuring of the Code R program in the next year or so.

SScAC members agreed that a good start had been made in addressing the issues identified in the TRTF report and congratulated Dr. Ulrich for the work that has been done. The TSG provides a mechanism for taking a comprehensive look at OSS technology needs and getting people to work together. Concerns continued about the implications of the transfer of the CETDP to OAT, and that situation will require continued careful scrutiny.

Following the presentations, the general Committee discussion centered on four subjects: General Armstrong's presentation on the NASA-University study; the Astrobiology Task Force Report; the Mars program presentation and the proposed Mars Program Task Force; and the Explorer program.

SScAC members commented that the NASA-University Study appeared to lack a clear focus. It was far from clear what its goals were, where it was headed, or what it would accomplish. There are many issues associated with NASA's relationship with the universities; and, so far, the understanding of those issues does not seem to be very deep. A more organized approach needs to be taken than simply collecting anecdotal information. Critical issues such as the appropriate balance between technology work done at the NASA Centers and at the universities are being ignored. Addressing the issue of the impact of ITAR on NASA research is very important, and there was some optimism that progress could be made in this area. In retrospect, it is unfortunate that work on this problem didn't start a year earlier.

Many of the issues discussed earlier concerning the proposed Astrobiology Laboratory were raised again. A number of members restated their opinion that, while a case might have been made concerning the need for additional funds for laboratory equipment, the case had not been made concerning the need for a large central facility. Dr. Dressler commented that the OS had heard from the advocates for the Laboratory and were still not convinced. Dr. Drake stated that the SDT task was to examine what could be done with such a building if it existed. The group was not asked whether the funds needed to equip and operate a Laboratory might be better used in other ways to meet the needs of this emerging field. Dr. Squyres and others noted that the Laboratory issue has become a very sensitive and controversial one that is receiving a lot of attention from various quarters. It must be dealt with thoughtfully and carefully. It will be considered further at the next SScAC meeting.

With respect to the Mars program and the proposed task force, SScAC again praised the work that had been done by Mr. Hubbard and his team. There was general agreement concerning the need for wide-ranging input into the process of redefining the Mars program. There was also consensus concerning the need for a high-level task force to work closely with Mr. Hubbard to provide a broad overview of the emerging program. However, a variety of views were expressed as to what the role of such a task force might be, and it was agreed that a better-defined Charter was needed. Concerns were also expressed as to whether any group set up under the advisory committee system would be large enough to have the right mix of skills to address the many critical issues facing the Mars program or would be able to meet frequently enough to keep on top of a situation that was changing so rapidly. It was pointed out that there is a large number of activities now underway providing information that is being factored into the replanning of the Mars program. For understandable reasons, there has been a focus to date on rapidly resolving near-term, time-critical issues such as the selection of the Mars 2001/2003 missions. Once the near-term issues have been dealt with, attention will turn to the planning of the longer-term program, and this is the area where the proposed task force can play a particularly important role. This subject will also be discussed further with Mr. Hubbard at the next SScAC meeting.

With respect to Explorers, Dr. Christensen again raised the issue of the effects of the imposition of new requirements for reviews, testing, and redundancy on the program. All of these are likely to have significant impacts on mission costs and adversely affect the scientific content of the Explorer program. Concerns were also raised about the apparent lack of support for the UNEX class of missions that emerged during the presentation made by Marcus Watkins. Issues affecting the Explorer program will be considered in more depth at a future meeting.

Wednesday, July 12

Recommendations

The balance of the morning was spent reviewing the text of draft recommendations prepared by small writing groups. The final recommendations emerging from this

meeting are presented in the letter from Dr. Christensen and Dr. Squyres to Dr. Weiler contained in Appendix D.

Discussion with the Associate Administrator for Space Science

Dr. Weiler (meeting with the SScAC via teleconference) began his discussion by reminding the Committee that this was a Presidential transition year and there was likely to be little about the FY 2002 budget process that would be normal. The Agency will transmit a budget to OMB in September; but, following the election, that budget will be revisited by the new administration in the December-January-February-March time frame. The real budget probably will not be submitted to Congress until the spring. He continued by noting that there are many budget problems developing, and dealing with these problems will result in significant slips in schedules, descoped missions, and perhaps even mission cancellations. The program he inherited was oversold and unrealistic. When the dust settles, he expects OSS to emerge with a program that may be a little slower and more expensive but that will be much more realistic. Costs of major new missions will be subjected to independent external cost reviews. Despite all the problems, he commented that significant new scientific results such as the evidence for the recent flows of surface water on Mars continue to emerge. He noted that the Mars program has already produced a veritable treasure trove of data and that he wanted to establish an aggressive, well-funded program for Mars Data Analysis in order to provide wider access to the existing data sets. He stated that, although the House action on the FY 2000 budget had eliminated the Living With a Star Initiative, he expected it to be restored by the Senate. His next priority is to establish a budget line for the Cosmic Journeys Initiative. In response to questions about Gravity Probe-B (GP-B), Dr. Weiler commented that the option he took to the Program Management Council (PMC) was to continue the program subject to the condition that it meet a rigorously defined series of critical milestones all the way up to launch. If the milestones are met, the money will be found to continue the program. If they are not met, GP-B will be taken back to the PMC for cancellation. So far, the program is meeting its milestones.

Dr. Squyres then reviewed with Dr. Weiler the major SScAC issues, findings, and recommendations emerging from this meeting. Specific topics addressed in-depth were the Astrobiology Laboratory, the Mars program replanning and proposed Mars Program Task Force, the Explorer program, and the NASA-University Study. The main points made by Dr. Squyres and the Committee are contained in the letter to Dr. Weiler. The following paragraphs are focused on key points raised by Dr. Weiler during this discussion.

Dr. Weiler commented that he has spent a lot of time on the Laboratory issue, and that, if budgetary trades had to be made to accommodate the Laboratory, the impact of such trades would not be just confined to the Astrobiology program. He needs a very clear position from SScAC on this issue and was pleased to learn that the Astrobiology Task Force and SScAC would be taking the time to examine this issue in more depth.

With respect to the Mars Program Task Force, Dr. Weiler and Mr. Hubbard both commented that there is a distinction between the need for having a continuing

mechanism for providing frequent, in-depth science input into the program planning and the need for obtaining long-term advice on and oversight of the planning and implementation of the total program from a group having a broad perspective. Meeting the first need is the appropriate role of a strong Science Working Group. Establishing the Task Force will begin the process of meeting the second need. Dr. Weiler also stated that he felt there was a need to take a closer look at the central issue of appropriately involving scientists in the planning and implementation of planetary missions. In general, he felt that they have not played a strong enough role to date.

Regarding the issue of mission risks in the Explorer program, Dr. Weiler noted that there is no clear definition of what acceptable risk is. This is a very soft area. The lessons learned from the Mars failures must be carefully applied. There is a clear difference between taking a prudent risk and violating accepted standard practices.

With respect to the NASA-University study, Dr. Weiler stated that Mr. Goldin wants universities to become more involved in all aspects of NASA programs. He noted that Codes S/Y are already deeply involved with the universities, but the situation is very different in the rest of the Agency. Achieving more university involvement in Agency technology programs through competition is an issue of particular interest. ITAR is a problem that must be dealt with at the highest levels of NASA if any progress is to be made. Real examples of problems are needed in order to demonstrate the impact of the regulations.

Dr. Squyres continued the discussion with the Associate Administrator by indicating the Committee's support for the planned Senior Review of the R&A program. He commented that identifying the right people to serve on the Review Panel was going to be a difficult job. He stated that SScAC appreciated OSS's efforts to increase the funding going into the scientific community. Elements of that community apparently still do not understand or appreciate the full range of sources of support going into research. This situation may be due to a very narrow view taken by certain disciplines within OSS concerning what kinds of work may be supported through Data Analysis funds. Dr. Weiler indicated that, in view of the efforts taken to increase research support, the issue had surprised him. There should not have been a controversy (and the perceived problem should not have been taken to Congress) when the reality is that the budgets are going up. Dr. Squyres also noted SScAC concerns about the reorganization of the technology program. Dr. Weiler indicated that there were a number of reasons that led to the decision to transfer responsibility for the CETDP to OAT. He understood the reasons for the concerns, and the situation would continue to be watched very closely. Finally, Dr. Squyres informed the Committee that Dr. Marc Allen will be the new SScAC Executive Secretary and thanked Dr. Rosendhal for all the work he had done to support the Committee over the past several years.

The next SScAC meeting will be held November 1-3, 2000, at JPL. The spring meeting will be held in Washington, DC, March 20-22, 2001. Because of the prospect of critical issues to be dealt with in conjunction with a Presidential transition, at Dr. Weiler's

request, the SScAC also tentatively scheduled an additional meeting January 30, 31, and February 1, 2001, at NASA Headquarters.

June 22, 2000-Version 5

Agenda
Space Science Advisory Committee Meeting
NASA Headquarters/ MIC 6
July 10-12, 2000

Monday, July 10

8:30 AM	Announcements/Meeting Introduction	Christensen
8:45	Mars Program Restructuring	Hubbard
9:30	Discussion	
9:45	OSS Strategic Plan	Allen
10:30	Discussion	
10:45	BREAK	
11:00	OSS Program /Budget Status (via telecon)	Weiler
12:30 PM	Lunchtime Science Talk: BOOMERANG	Ruhl
1:30	Ethics Briefing	Falcon
2:15	Reports from Subcommittees (30 minutes each)	
	- Structure & Evolution of the Universe	Margon
	- Astronomical Search for Origins	Dressler
	- Solar System Exploration	Drake
	- Sun-Earth Connection	Christensen
4:15	General Discussion	
5:30	ADJOURN	
6:30	SScAC DINNER: West End Café, One Washington Circle, NW	

Tuesday, July 11

8:15 AM	Chairman's Report	Squyres
	- Technology Task Force Report	
	- Planetary Protection Advisory Committee	
8:45	Explorer Program Status	Watkins
9:45	Discussion	
10:00	NASA-University Study	Armstrong
10:30	Discussion	
10:45	Astrobiology Task Force Report	Beichman
	- Astrobiology Laboratory	
11:30	Discussion	
NOON	Working Lunch	

1:00 PM	Theme Status Reports (15 minutes each)	
	- Structure and Evolution of the Universe	Bunner
	- Astronomical Search for Origins	Kinney
	- Solar System Exploration	Pilcher
	- Sun-Earth Connection	Withbroe
2:00	Research Program Report	Riegler
	- Senior Review Process/Performance Metrics	
2:30	Discussion	
2:45	NASA/OSS Technology Program Reorganization	Ulrich
3:15	Discussion	
3:30	Committee Discussion/Preparation of Recommendations	
5:30	ADJOURN	

Wednesday, July 12

8:15 AM	Announcements	Squyres
8:30	Discussion/Preparation of Recommendations	
11:15	Report to the OSS Board of Directors	Squyres
NOON	ADJOURN	

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Dr. Jeffrey D. Rosendhal (*Executive Secretary*)
Assistant Associate Administrator for
Space Science (Education and Outreach)
NASA Headquarters, Code S
Washington, DC 20546-0001

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)

NASA Headquarters

July 10-12, 2000

MEETING ATTENDEES

Committee Members:

Squyres, Steven (Chair)	Cornell University
Christensen, Andrew	The Aerospace Corporation
Das, Alok	AFRL/VSC
Drake, Michael	University of Arizona
Dressler, Alan	Carnegie Observatories
Farmer, Jack	Arizona State University
Gehrz, Robert	University of Minnesota
Hathaway, David	NASA/MSFC
Macauley, Molly	Resources for the Future
Margon, Bruce	University of Washington
Mewaldt, Richard	California Institute of Technology
Papike, James	University of New Mexico
Richstone, Douglas	University of Michigan
Rosendhal, Jeffrey (Executive Secretary)	NASA Headquarters
Smith, William	AURA
Zuber, Maria	MIT

NASA Attendees:

Allen, Marc	NASA Headquarters
Armstrong, Spence	NASA Headquarters
Beichman, Chas	JPL
Brody, Steven	NASA Headquarters
Bunner, Alan	NASA Headquarters
Connerton, Bob	NASA Headquarters
Correll, Randall	NASA Headquarters
Falcon, Andrew	NASA Headquarters
Frederick, Suzanne	JPL
Grant, John	NASA Headquarters
Hartman, Colleen	NASA Headquarters
Hertz, Paul	NASA Headquarters
Hubbard, Scott	NASA Headquarters
Jones, W. Vernon	NASA Headquarters
Kinney, Anne	NASA Headquarters
Mellott, Mary	NASA Headquarters
Morrison, David	NASA/ARC
Netting, Ruth	NASA Headquarters
Norris, Marian	NASA Headquarters

Pilcher, Carl
Riegler, Guenter
Rummel, John
Six, Frank
Sorrels, Carrie
Ulrich, Peter
Vondrak, Richard
Watkins, Marcus
Withbroe, George

NASA Headquarters
NASA Headquarters
NASA Headquarters
NASA/MSFC
NASA Headquarters
NASA Headquarters
NASA/GSFC
NASA Headquarters
NASA Headquarters

Other Attendees:

Akin, David
Andreoli, Leo
Appleby, John
Armstrong, Kirsten
Beres, Kathleen
Brennan, Don
Cornelius, Craig
Cowing, Keith
DiBiasi, Lamont
Herman, Daniel
Hescheler, Heather
Ho, Kenton
Hopkins, Joanne
Obermann, Richard
Reese, Terry
Ruhl, John

University of Maryland
TRW
APL
National Research Council
TRW
Orbital Sciences
NRC
NASA Watch
L. DiBiasi Assoc.
Consultant
Ball Aerospace
TRW
SRI International
U.S. Congress
Lockheed Martin
UCSB

FINDINGS AND RECOMMENDATIONS

Cornell University
Center for Radiophysics and Space Research

December 2, 2002

Dr. Ed Weiler
Associate Administrator for Space Science
NASA Headquarters
Washington, DC 20546

Dear Ed:

The Space Science Advisory Committee (SScAC) met at NASA Headquarters on July 10-12, 2000. Because schedule conflicts required that this meeting be co-chaired by Andrew Christensen and Steve Squyres, this letter comes from both of us.

One of the highlights of the meeting was hearing from George Withbroe about the growth in research funding to the space science community. This includes both R&A and Data Analysis funding, all of it subject to open competition and peer review. George showed us that not only has recent growth in NASA's support for peer-reviewed science been significant, but also that future growth is projected at a rate that substantially exceeds inflation. *This funding is crucial to the vitality of space science in the United States, and we vigorously applaud the Space Science Enterprise's continued and strong support.*

It is noteworthy that the growth in funding is mostly in the data analysis portion of the program. Concentration of the growth in this area is appropriate given the increase in the flight rate in recent years, as well as the Agency's basic mission-driven character. With most of the growth in this area, it means of course that data analysis must be broadly defined: always tied to the scientific goals of the mission in question, but inclusive of relevant theoretical work, laboratory work, and so forth. Broad, inclusive data analysis programs have long been the hallmark the Code S program; the SEU, SEC, and Origins themes have all provided good examples. We

were pleased to hear from you that you intend to strengthen and broaden DA programs across all of Code S.

We also considered a number of other issues, and our findings and recommendations concerning them are summarized below:

NASA Astrobiology Research Laboratory

Chas Beichman, chair of our new Astrobiology Task Force (ATF), delivered an interim report on the ATF's review of the proposed NASA Astrobiology Research Laboratory (NARL). Their review was based on interactions with the NARL Science Definition Team (SDT) chaired by Don Lowe; they have not yet been able to meet with NARL advocates from NASA Ames. *The opinion of the task force based on their work to date is that they do not see a compelling need for a centralized national facility of the sort proposed.* In considering this opinion, we were somewhat concerned about the abbreviated timeframe of the ATF's work to date, and about the lack of interaction with Ames. However, we were satisfied, aided by comments from Bruce Jakosky and Ken Nealson from the NARL Science Definition Team, that the conclusions reached so far have not been compromised significantly by these deficiencies.

We note that the three science areas identified by the SDT as potentially worthwhile activities of the NARL — detection of life and prebiotic materials, environmental simulation, and computational biology — may well emerge as essential components of the Astrobiology program, even though a compelling case has not yet been made that a central facility is required to further them. In our opinion, specific proposals for these or similar initiatives would best arise from the community itself, rather than precipitate from the availability of a building. In particular, we look for such initiatives to arise from the NASA Astrobiology Institute or other extant astrobiology programs, as does not appear to have been the case here.

We strongly endorse two key points made by the ATF. First, *any funding for the NARL should not be provided at the expense of current Astrobiology R&A programs*, which are already stressed in terms of funding, *or at the expense of any other ongoing activity within Code S.* Second, *should the case for a national astrobiology laboratory become compelling, this facility must be openly competed and selected by peer review.*

We understand that you have asked the ATF to reconsider its recommendations at its next meeting (October 2000, at Ames), when the final SDT report will be available and the ATF can hear from NARL advocates at Ames. In response to this development, we expect to review the situation again at our next meeting in November.

Mars Exploration Program

We heard our first report from the new Mars Program Director, Scott Hubbard, on the status of the Mars Program. *We were pleased to see that the new Mars*

management structure that Scott described provides for strong Headquarters leadership and clear lines of responsibility, consistent with the recommendations of the Mars Program Independent Assessment Team (MPIAT).

We recognize that the Mars Exploration Program is in a state of flux as it undergoes intensive re-evaluation of goals, objectives, resources, and schedule. We strongly endorse the methodical approach that Scott is taking, which engages the broad community. His four-part plan to get input through a Request for Ideas from industry, science workshops, input from NASA Centers, and input from international partners, is a sound way to obtain the diverse advice necessary to construct a robust program. We also agree that as early as possible, engineering expertise must be included in the planning process. The Mars Program needs to be visionary, yet realistic.

In order to help Scott with his work, we recommend the immediate establishment of an SScAC Mars Exploration Program Task Force. This group should deal with the full spectrum of issues impacting the Mars program: science, engineering, technology, and programmatic. Along with reporting to SScAC, it also must communicate effectively with the SSES. Some common membership with the SSES may be appropriate.

Our new Mars Exploration Program Task Force is necessary, but it is not sufficient to help Scott deal with all of the scientific challenges that are faced by the Mars Program. In order to formulate a robust new plan, Scott will also require expert scientific input in much more detail and much more frequently than the task force can provide. Some kind of science working group, drawn from the broad Mars science community, is therefore also necessary, both in the short and long term.

Planetary Protection Advisory Committee (PPAC)

We had a brief discussion of NASA's new Planetary Protection Advisory Committee. At the last NASA Advisory Council meeting, the NAC voted to establish the PPAC, reporting to you as a subcommittee of the NAC. We reiterate that ***the PPAC should include scientists from the fields of Astrobiology and planetary materials, and that there should be cross membership between the SScAC and PPAC*** in order to facilitate effective communications. We have been invited to comment on the wording of the PPAC charter, and we will do so at the next NAC meeting.

Explorer Program

Marcus Watkins reported to us on the status of Explorer class missions. An issue of particular interest that emerged is the fallout from the MPIAT report. We of course want all Explorer missions to be successful, and we strongly support OSS efforts to assure the reliability of these missions. But we also realize that such efforts will tend to increase mission costs and reduce science content and flight rate. This pendulum must not be allowed to swing too far, or the result could be to select against innovative and important

science programs. ***The cost of risk aversion in the Explorer Program should not be allowed to exceed the savings gained in reliability.***

We also point out that it is vital to distinguish among different kinds of risk. As pointed out in the MPIAT report, examples of unacceptable risks include mission failures from which little or nothing can be learned, or cases when the failure can be traced to a simple mistake that should have been caught in the normal processes of management or review. This is to be contrasted with acceptable risk based on pushing the technological envelope for the benefit of scientific progress. We urge that lessons learned from the Mars Program be applied to the selection and development of Explorer-class missions in a way that takes account of these considerations.

NASA-University Initiative

We heard from Sam Armstrong about NASA's establishment of a new initiative to strengthen the Agency's relationship with the university community. This relationship has been essential to the success of the space sciences as well as other NASA enterprises since the early days of the space program, and we commend the Agency for focusing new attention on it.

A strong focus for Gen. Armstrong's effort will be important, as will be articulating a clear set of goals and defining what the final product will be. Areas he has identified so far where the initiative could be important include compliance with the International Traffic in Arms Regulations (ITAR), and the overall management of NASA's grants program. We concur with these, and we particularly encourage the efforts to clarify ITAR issues; this is an area of serious concern at many universities. There are other issues that should be addressed as well — one good example is the role that the university community can play in technology development.

In order to fully exploit this opportunity and create a stronger relationship between NASA and the university community, ***we urge that NASA seek input from the university community at all levels, including the traditional PI community*** as well as university administrators. We look forward to seeing a carefully articulated set of goals for this effort at a future meeting, as well as an outline of the process that will be followed and the product that the community can expect.

Technology Readiness Task Force

We received the final report of our Technology Readiness Task Force (TRTF) at this meeting, which is appended to this letter. We are in full agreement with its contents. We also heard a presentation from Pete Ulrich on how Code S will utilize technology funds and interact with Code R under the latest reorganization. Careful thought has led to an effective start on these complex problems. All parties have the same goal: to use the available funds to most rapidly create the best, most innovative missions.

We remain concerned that despite the recent reorganization, barriers remain in advancing technology from concepts to missions in the most efficient way. In particular, how Code S can address the longer-term issues in the TRTF report remains unclear, and the latest structure still tends to feed technology to individual missions rather than fully exploiting crosscutting issues. We encourage aggressive monitoring of the pros and the cons of the new structure, with the goal of discussing the matter again with SScAC in one year.

Research Program

As usual, we heard a report from Guenter Riegler about the Code S research program. The reorganization into clusters appears to be proceeding well, and Guenter is on track to set up the first Senior Review. We reiterate the importance of this review to the program, and we wish Guenter success in conducting it. We stand prepared to help in any way that we can.

As a final point, we heard from Jeff Rosendhal that this was his last meeting as Executive Secretary of SScAC. We'd like to thank Jeff warmly for his wonderful support of the committee's activities. If SScAC has been of use to Code S and the Agency in recent years, it has been largely as a result of Jeff's efforts.

That summarizes the results of our meeting. Please don't hesitate to contact me if you would like any clarification or further detail on any of the points that we've raised above.

Best wishes,

**Steve Squyres
Chair, SScAC**

**Andrew Christensen
Chair, SECAS**

**cc: SScAC
B. Parkinson
L. Garver
J. Rosendhal
J. Alexander**

8 May

2000

MEMORANDUM FOR SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
DR. STEVE SQUYRES

FROM: Dr. Daniel Hastings, MIT
Christine Anderson, AFRL
Cochairs, Task Force for Technology Readiness

SUBJECT: Technology Readiness Task Force Recommendations

1. The NASA Task Force on Technology Readiness conducted a review of near (2007) and far (2015) technology in support of the NASA Space Science Strategic Plan in September 1999. The Findings of the Task Force were reported to the Space Science Advisory Committee on 1 March 2000. Recommendations follow.

2. **Inadequacy of Funding.** The Task Force found a large imbalance in the resources available among the four Science Themes (as much as an order of magnitude difference). Thus the ability of the two Themes SEC and SEU to execute their portion of the Strategic Plan is questionable. We understand that the current President Financial Plan (PFP) contains a substantial augmentation that resolves some of these concerns for the SEC & SEU Themes. **The Task Force recommends that all programs be examined and adjustments be made to reflect funding realities and Agency priorities.**

3. **Program Organization and Management Structure.** Fundamentally the Task Force found that the management structure and process ownership of the technology development is fragmented. This could jeopardize the achievement of the goals of the Strategic Plan. **We recommend a management approach that integrates requirements and technology development efforts, establishes uniform standards, and guards against duplication as well as missing developments. This must be done with support and participation from applicable NASA centers. Incentives for cross center teaming must be developed and implemented. We specifically recommend that such technology management focus on:**

- a. Integration across themes;
- b. Long-term planning to accommodate multiyear technology development efforts;
- c. Infrastructure capabilities supporting multiple missions
- d. Exit criteria for the termination of a technology effort or its infusion into a flight development program
- e. Assessment and mitigation of technological risk, and
- f. Collaboration with other agencies sponsoring related technologies.

At the SScAC meeting in March 2000, we were informed that Dr. Ulrich has formed a Technology Steering Group chartered to construct and maintain a database of all the technology development efforts sponsored by the Space Science Enterprise; to perform analyses; and identify "gaps" and opportunities for synergism. This appears to be a good foundation, but not a substitute for a strong management function and future cross center/cross theme planning.

In view of more recent events, subsequent to the conclusion of our review, it seems appropriate to emphasize the issue of mission risk, noted above. **Thus we recommend that systems analyses be undertaken for NASA to understand better the role of advanced technology as a potential source of risk and also as a tool for risk reduction.**

4. Infrastructure Capabilities. The task force found that there appears to be no systematic approach for identifying infrastructure capabilities needed by Space Science as an Enterprise and common to several missions. New infrastructure capabilities might include: handling of samples returned from planets, comets, and asteroids; exploiting the exploding information technology to the conduct of space science; and upgrading and expanding the planetary communication network. One infrastructure effort that was described to the Task Force is the Intelligent Synthesis Environment: indeed it has the potential for changing the design and cost paradigm of space science missions. However, the program, as structured, has diffuse goals and no metrics and appeared to represent more a bolting together of software packages than an intellectual investment.

We recommend that a cross theme peer-reviewed effort be undertaken to identify infrastructure needs at a minimum in the areas of: information technology – as it supports Space Science Enterprise activities; interplanetary communication networks; planetary protection; and handling of samples retrieved from other celestial bodies. Initiatives deemed worthy of implementation should be funded by reprioritizing the existing budget

5. Leveraging of Other Agencies' R&D. We found that there was inadequate awareness and leveraging of similar technology work being pursued elsewhere. We felt this was particularly evident in the SEC presentations, but it was common to all themes. The potential leverage and savings are so substantial that, at the national level, it is mandatory to pursue interagency collaborations whenever possible. We commend NASA for trying to get other agencies to participate in NGST and wish to encourage other cross agency efforts as appropriate. **Thus we recommend that activities and incentives be put in place – at all management levels – to overcome the known obstacles and create a work environment where such collaborations become part of the natural conduct, and that Centers participate more fully in the Space Technology Alliance, and consider appointing senior (SES level) representation to the Alliance in addition to the Headquarters representative.**

6. Continuing Review Process. The Task Force on Technology Readiness felt the past year's review was a valuable exercise and **recommends that a broad periodic independent technology review be made a routine part of NASA Space Science planning, on a biennial basis, just as the DOD has done with Scientific Advisory Board reviews.**

CHRISTINE M. ANDERSON, SES
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DANIEL HASTINGS, PhD
Professor, Aeronautics and
Astronautics
MIT

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)

NASA Headquarters

July 10-12, 2000

LIST OF PRESENTATION MATERIAL¹

- 1) Mars Exploration Program [Hubbard]
- 2) Summary of SSB comments on OSS Strategic Plan [Allen]
- 3) Space Science Enterprise [Withbroe]
- 4) Structure and Evolution of the Universe Subcommittee Report to SScAC [Margon]
- 5) Report of the Origins Subcommittee to SScAC [Dressler]
- 6) Solar System Exploration Program [Drake]
- 7) Report to SScAC – SECAS Meeting [Christensen]
- 8) Explorer Program Status [Watkins]
- 9) Report by the Astrobiology Task Force: The NASA Astrobiology Research Laboratory (NARL) [Beichman]
- 10) Space Science Enterprise Technology Program Reorganization [Ulrich]
- 11) Supporting Research and Technology [Riegler]
- 12) Structure and Evolution of the Universe [Bunner]
- 13) Sun Earth Connection Report to SScAC [Withbroe]

Other material distributed at the meeting:

- 1) Comparison of Criminal Conflict of Interest Statutes and Other Ethics Related Provisions Applicable to Special and Regular Government Employees
- 2) Human Exploration and Development of Space (HEDS) Strategic Plan
- 3) Letter from Co-Chairs of the Task Force for Technology Readiness to Dr. Squyres—Technology Readiness Task Force Recommendations, May 8, 2000
- 4) Draft Terms of Reference for the Mars Exploration Task Force

¹Presentation and other material distributed at the meeting are on file at NASA Headquarters, Code S, Washington, DC 20546.